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THE AUSTRALIAN METEOROLOGICAL ASSOCIATION

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Mr. T.G. Keen
All correspondence relating to "*MONANA*" should be addressed to the Editor:

Mr. T.G. Keen,
C/o Scotch College,
MITCHAM, S.A. 5062

OTHER correspondence relating to the Association should be addressed to:

The Secretary,
Australian Meteorological Association,
Mrs. J. Bannister,
196 Walkerville Terrace,
WALKERVILLE, S.A. 5081

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WEATHER AND GLIDING

by C. E. Wallington

No other sport is so interwoven with the ways of the weather as gliding. To keep his aircraft in the air the glider pilot must search for and fly in rising air. Rising air is the essential ingredient in almost all the phenomenon we call weather. Almost all clouds are born and feed in rising air - in bands, zones, columns and patterns which are still being discovered, not only by meteorologists but by glider pilots themselves.

GLIDING TECHNIQUES

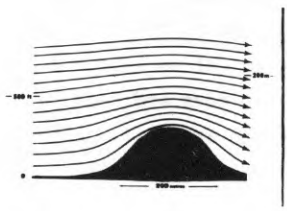
The last forty years have seen extraordinary progress in glider performance and the science of soaring flight. A modern fibreglass glider can remain airborne in air that is rising at only half a knot (about fifty feet per minute) and from a height of 5000 feet it can glide almost 70 kilometres (about forty miles) in still air. All modern gliders are fully instrumented with air speed indicators, altimeters, particularly sensitive rate of climb indicators, special compasses and, radio and oxygen equipment if necessary - blind flying instruments in countries where flying in cloud is permitted.

There are four methods of launching a glider. When fresh winds blow up and over a hill ridge a simple catapult launching system can be used to project gliders off the hilltop into the wind. Another method is to use a winch or tow-car to haul a glider at the end of a long wire up to a height of about 1500 feet. The most common method is to tow the glider up by light aeroplane to about 2000 feet; and the fourth method, which has recently been developed mainly for training machines, is to build a light-weight, and sometimes retractable, engine into the glider, which then becomes self-launching without losing its gliding efficiency when the engine is switched off in the air.

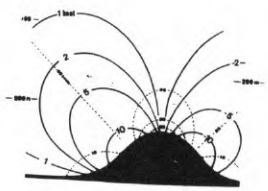
AIRFLOW OVER MOUNTAINS

The earliest known and most obvious way of staying airborne in a glider is to soar in rising air up and over the windward escarpment of a hill ridge. Hill soaring, as it is called, is still practised throughout the world; but there are more interesting features of airflow over mountains that the glider pilot likes to explore. Mountainous countries, such as Switzerland and Austria provide opportunities for soaring in anabatic winds that stream

up steep mountain sides heated by the sun. These upslope winds are very shallow; the pilot has to fly close to the mountain sides - keeping a good look-out for any glider coming the other way around, ~~butte~~. It is exciting, but an even more interesting mountain airflow phenomenon is the lee wave.

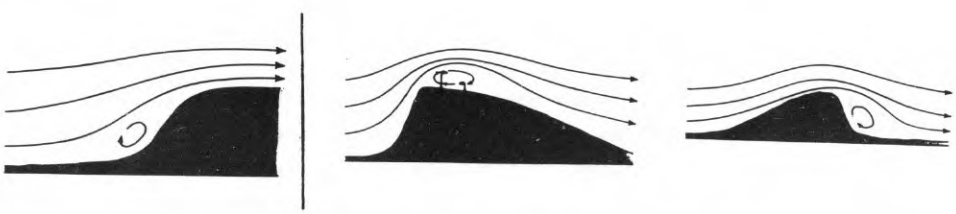


Hill soaring is possible in fresh winds blowing across a hill ridge



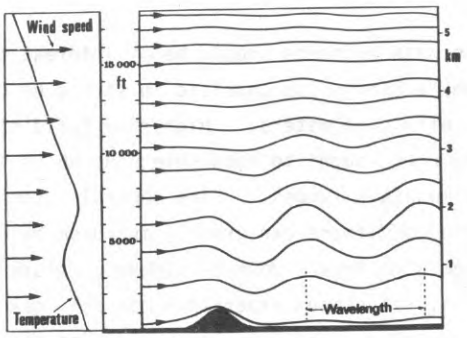
Typical pattern of horizontal and components (broken and full lines) of the airflow illustrated

In certain atmospheric conditions, a mountain ridge triggers off a wave-like motion in the airstream. This type of air motion starts with a strong flow down the leeward escarpment before undulating up and down in a lee wave pattern. The pattern itself is more or less stationary - the air simply flows through it. So in the lee of mountains there are alternate zones of ascent and descent (or in gliding jargon; lift and sink) as the air flows up to the crest of each wave then down to the trough. The presence of lee waves is often portrayed by lee wave clouds whose shape traces out the wave pattern. Such a cloud is almost stationary; it is maintained by a continuous process of condensation of water vapour at the leading edge of the cloud and evaporation at the trailing edge.



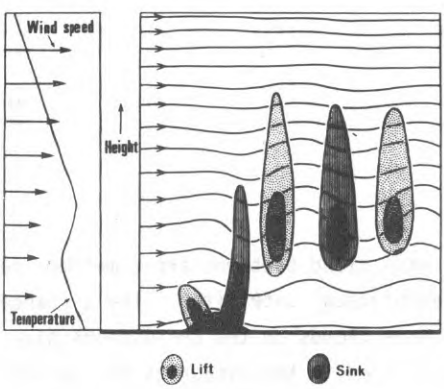
Glider pilots are wary of "bolster" eddies likely near steep escarpments

Underneath the wave troughs, where streamlines dip down towards the ground, winds are liable to be particularly strong. When gales blow across mountain ridges the strongest winds are not always on the exposed mountain crests; in lee wave conditions the gales are sometimes at their worst downstream of the mountain ridge in bands underneath the mountain troughs.



A shallow stable layer, or temperature inversion, in an airstream with fresh or strong winds usually produces lee waves over hilly terrain.

Aviators, particularly glider pilots, have contributed more to lee wave observations than any other class of observers. In America gliders have been used in several major projects to explore the frequently observed wave flow in lee of the Sierra Nevada Ranges. Gliders used in these projects were usually towed by powered aircraft up to about 12 000 feet - into an updraught in the waves. From there on the glider pilot relied on lift in the wave flow to gain height. Frequently their explorations took them up to between 30 000 and 40 000 feet.



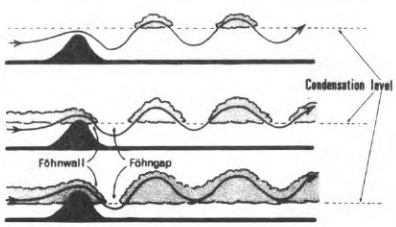
Vertical components of the lee wave flow illustrated above. Glider pilots can soar in the cells of rising air.

The world gliding altitude record, made in Sierra wave conditions, stands at 46 000 feet. This will certainly be exceeded if and when pressurised gliders become available.

Although lee wave flow is often extraordinarly smooth, some zones of the flow can harbour chaotic and turbulent motion - particularly at low levels. Wave clouds that form in the crest of lee waves that become turbulent are usually ragged and appear to rotate about horizontal axis. Such a cloud is called "roll cloud" and the turbulence is known as "rotor flow".

Lee wave patterns should be of interest to more than just glider pilots. Many a dinghy has capsized in strong or chaotic lee wave winds over inland or off-shore waters. High rise building constructors and pollution control engineers ought to know something about lee waves in localities overshadowed by mountain ranges. Fire control authorities should also know that lee wave conditions can greatly increase bushfire hazards. As air descends from high levels down to higher pressure it is compressed, warmed and dried. Thus, lee slopes experience not only gale force winds but also the high temperatures and very low humidities that go towards high fire risk. Sometimes lee wave conditions help to force more air than usual through mountain passes, and this effect may well add to the gully wind effects like those experienced in the Adelaide region.

The pattern of lee wave cloud depends on the height of the condensation level.



Lee wave cloud patterns are sometimes detected on photographs from metereological satellites. The distances between the faint white bars of lee wave clouds on the photographs give a measure of wavelengths, and this can be used to test theories for calculating flow patterns over mountains. High speed computers are needed for these calculations, but the results can be of value to a variety of engineers and research workers, including those who are concerned with the high level turbulence occasionally encountered by jet aircraft.

CONVECTION

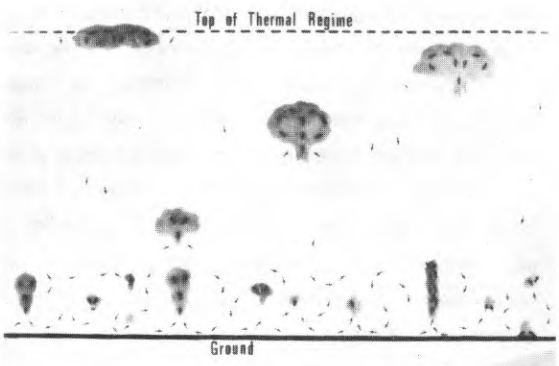
Although airflow over mountains is of great interest to the glider pilot, he makes by far the majority of his cross-country flights in convection currents - currents of warm buoyant air that arises from ground heated by the sun. Such convection currents - or thermals as they are called - are often capped by puffy white cumulus clouds.

The ascent of buoyant air does not occur in a steady regular pattern; it is a mixture of chaos and coherence. The chaos is the eddy motion or small scale turbulence; the coherence is found in the apparently more organised structure of thermals. An incipient thermal rises from the shallow heated layer near the ground as a dome-shaped proturberance which develops into a column with a diameter of between about one hundred and three hundred metres. Its initial velocity is about two knots (one metre per second), but in weak thermal conditions this initial velocity is often much less. The column accelerates as it rises, and its diameter may decrease. Higher up, the diameter gradually increases and the thermal begins to assume the shape of an inverted cone. In weak or moderate conditions this column may break away from the heated ground layer and form an isolated bubble of rising air. But in some situations, expecially very hot and dry conditions, a thermal column may draw up air from the heated ground layer for several minutes before exhausting the temporary supply. As the column rises it spreads laterally by entrainment with the surrounding air; the bottom of the column rises up into the thermal as a whole, and the structure begins to acquire the characteristics of a vortex ring. Isolated thermal bubbles also tend to spread out laterally as they rise and acquire vortex ring characteristics, so that as the bubble and the column types of thermal ascend well into the thermal layer of the atmosphere they both tend to acquire the vortex ring characteristics.

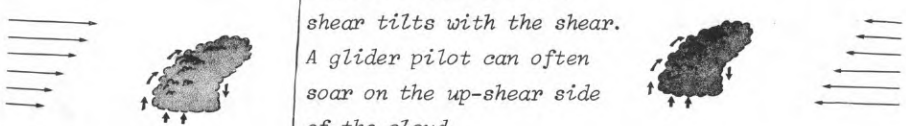
At low levels a thermal rising from ground level usually takes the shape of a narrow inverted cone. As it rises it begins to acquire the characteristics of a cortex ring with an eroding tail.

Below the condensation level for convection cloud the thermals are called "dry thermals". On good thermal soaring days they attain average rates of ascent of between about three and six knots, although a few may rise at ten knots or more if the convective layer is deep and is heated by particularly strong sunshine.

In the lowest few hundred feet of a thermal convection layer (ground level up to a stable layer or inversion) thermals are small and often dissipated in turbulence. At higher levels, they are fewer but better developed. At the top of the thermal layer they spread out and decay.



Fresh wind can distort thermal upcurrents, but sometimes it more than compensates for this distortion by organising convection into patterns of streets along which the glider pilot can fly for miles without circling. When cumulus cloud forms the streets are marked by lines of cloud, but on cloudless days the pilot has to use his meteorological knowledge to visualise the pattern of dry thermals that may exist.



Cumulus cloud in a wind shear tilts with the shear. A glider pilot can often soar on the up-shear side of the cloud.

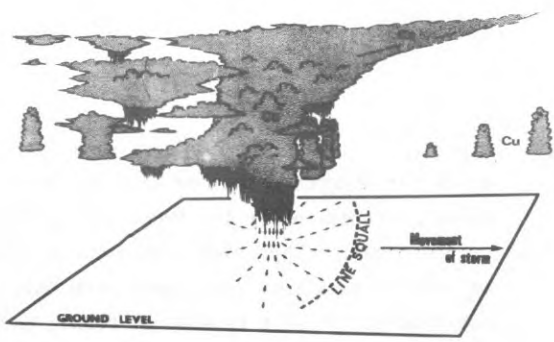
In countries where cloud flying is permitted, glider pilots sometimes venture into large cumulus clouds - or even cumulonimbus.

In some such clouds updraughts and downdraughts are likely to be very strong, but not always turbulent. Above the freezing level ice will form on the aircraft, but it is not necessarily a serious hazard. Electrical discharges are more frightening than dangerous, but the glider pilot's real worry is the risk of hail; hail damage to his aircraft can be very expensive.

THUNDERSTORM DOWNDRAUGHTS

The glider pilot knows that large cumulus may well grow to cumulonimbus with thunderstorms. He also knows that cold downdraughts from such storms can spread out to give squally winds at ground level. Sometimes this cold air spreads out a very long way from the parent storm. The leading edges of such downdraughts are often sharp, and in some countries, including our own, they may be accompanied by a wall of dust or sand whipped up by the strong gusty winds. But the glider pilot can turn this effect to his advantage; the cold air acts as a wedge prising up the air in front of it, and many a pilot has soared just in front of the squall line.

Downdraught from a convective storm can spread out over the ground and produce a line squall. The cold air spreading out acts as a wedge undercutting the surrounding warmer air. Glider pilots can soar in the rising air ahead of the wedge.

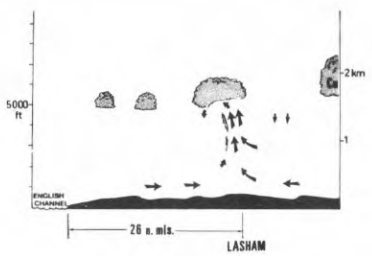


The thunderstorm downdraught effect belongs to a class of phenomenon that is usually too small to be detected quickly and accurately in routine networks of weather observations, but too big to be observed completely from one spot. Phenomena in this class are difficult to investigate and predict, but they are important not only to glider pilots but to practically everyone in the regions affected. In many urban areas there is ample scope for universities and schools to collaborate on observational projects to study these phenomena.

SEA BREEZES

It is common knowledge that sea breezes blow from the sea inland. Most glider pilots also know that where the sea air converges with the inland air flow there is often a narrow band of rising air. This tends to occur along a sea breeze front, as it is called, that moves steadily inland during the day. In fact, the front often persists and continues moving slowly inland until well into the night. The zone of rising air is usually very narrow, only

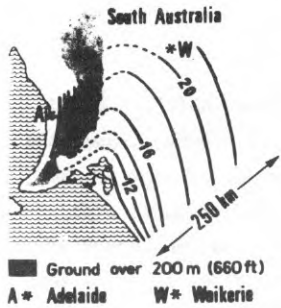
Cross-section of a sea breeze front. Between the converging sea breeze and air inland, there is a narrow (about 100 metre wide) zone of rising air.



about one hundred metres or so wide, but it is sometimes marked by a line of cloud. Occasionally the front can be detected by smoke on one side but not on the other, or by smoke plumes converging towards the front. A glider is an ideally sensitive instrument with which to probe this type of phenomenon, but studies can also be made by people on the ground who know what to look for. Here too, there is scope for amateur observers in schools and universities to embark on projects aimed at mapping the progress of sea breeze fronts in their areas. The equipment they need is not expensive, especially when compared with the educational value of its purpose.

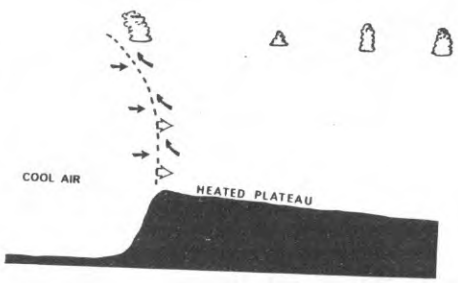
Coastlines are not the only topographic features that can create a low level temperature gradient to trigger off a sea breeze front. The edge of a very broad sheet of cloud can also produce a sharp temperature contrast between ground overshadowed by the cloud and the adjacent sunlit terrain.

Penetration of a sea breeze front inland can be blocked or reduced by high ground - as shown by these typical isochrones of sea breeze fronts over South Australia.



This differential heating can produce a pseudo-sea breeze front that moves away from the edge of the cloud towards the sunlit area in just the same fashion as a real sea breeze front moves inland from a coastline. The edge of a broad plateau of high ground can also produce a temperature contrast between the heated plateau and the relatively unheated air at the same level as the plateau over the adjacent lowland. Here too, if the heating is sufficient, a psuedo-sea breeze front forms and moves in over the plateau from the escarpment.

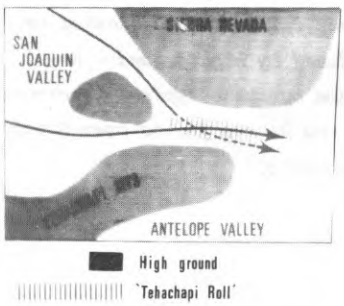
Differential heating between a plateau and air at the same level over the adjacent lowland can produce a pseudo-sea breeze front that moves in over the plateau.



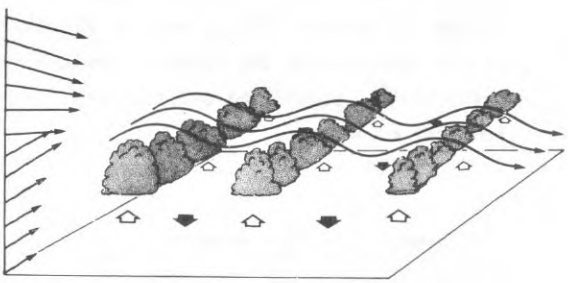
FRESH FIELDS TO EXPLORE

Glider pilots are always looking for new and more interesting sources of rising air. In recent years they have explored and tracked sea breeze and pseudo-sea breeze fronts; they have discovered an unsuspected persistence of wind shears in convectively well mixed layers; they have discovered convergence lines in lee of isolated mountains, and have led observational research into moving waves in the atmosphere, especially waves that can exist above thermal or cloud streets.

The "Tehachapi Roll" (U.S.A.) in which air flowing around the opposite sides of high ground converges and produces lift (rising air) as one branch of the airflow flows over the top of the other.



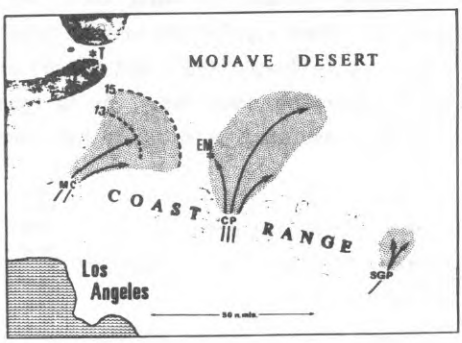
A wind shear over the top of a system of thermal or cloud streets can produce "thermal waves" that have been discovered by glider pilots during the past ten years.



Even if they do not discover phenomena for themselves, many of their enquiries trigger off investigations by meteorologists. I have been asked, quite seriously, to advise on planning a glider flight across the North Atlantic. It may well be possible to do this at high levels in a jet stream. In theory, at least, there should be long bands of slowly rising air in jet streams and it should be just possible for a glider with a sinking speed of less than one metre per second to remain airborne at about 35 000 feet and go with the winds which are likely to be 150-200 knots. If this were done it would be a triumph, not so much for the pilot because, by himself, he would not be able to detect

where to go to remain in the rising air or the strong tailwinds; he would probably be flying in thin milky white cirrus cloud and under the control of a ground organisation. He would see very little - and undoubtedly he would need great faith in the ground organisation directing his flight.

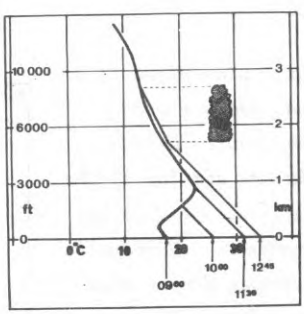
Smog from Los Angeles penetrating through mountain passes often has a sharp leading edge and behaves like a pseudo-sea breeze front along which gliding pilots can soar. The 13 and 15 are typical locations at 1300 and 1500 hours local time.



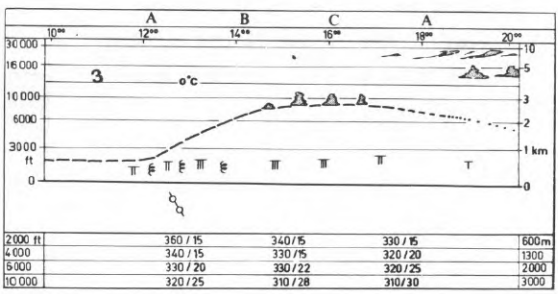
COMPETITIVE GLIDING

Glider pilots no longer compete with each other merely to see who can stay up the longest, and they seldom compete to see who can fly the farthest. Now-a-days almost all competition flying is racing. Each day of a gliding contest usually means racing around one circuit of a set course. Because the choice of a suitable course depends critically on the weather prediction in detail for the day, the course is not set until the day. Most courses are triangular and are of between about 100 and 400 miles long.

A local temperature/height curve for early morning and predicted changes due to the sun's heating are particularly important in a forecast for gliding.



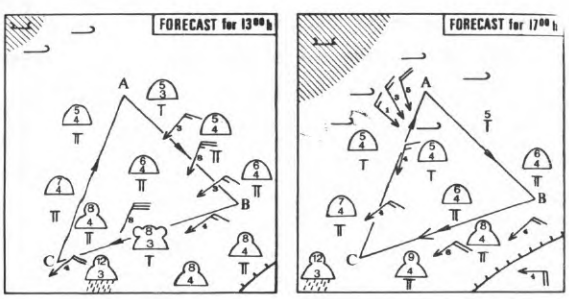
After the weather has been considered, the task set and the competing pilots briefed, the contest is started at about middle or late morning. The competing gliders are towed off in rapid succession to a height of 2 000 feet, and pilots usually fly around the locality for a while to assess conditions for themselves and to choose their own individual times for setting off on course. When a pilot decides to make a start, he flies across a starting line, and follows a radio and flight procedure that enables his starting time to be accurately recorded. As he rounds the turning points, he photographs them to prove that he actually has gone around the course; and he finishes the



Pictorial cross-section of weather forecast for a closed-circuit race (A-B-C-A). The T-shaped symbols denote thermal strengths; springs, dust devils; and the two joined circles, the direction of cloud streets.

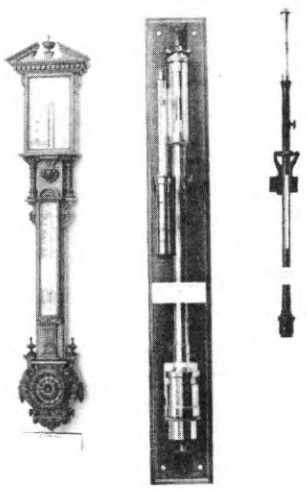
race with a long (20-50 miles) final glide aimed at crossing the finishing line at between about 200 and 500 feet.

Although he needs rising air to remain airborne around the course he cannot take too long to search for it and use it. Every time he circles in a thermal, he may gain some height, but he is not necessarily making progress along the course. He must continually assess the optimum speeds and patterns to fly along the course.



Schematic plan views of forecast weather over a closed-circuit (A-B-C-A). Symbols are similar to the international meteorological symbols. Numbers in cloud shapes denote base and top of cloud in thousands of feet.

It is little wonder, therefore, that the glider pilot's thirst for mesoscale and fine scale detail of weather forecasts can both tax the skill of professional meteorologists and provide information that is not normally gleaned from meteorological research. The glider pilot's observations may be casual and amateur but they can shed light on phenomena that are vital links between the broad scale flow patterns we see on daily weather we actually experience. Meteorologists who fly themselves or who are involved in gliding can provide a particularly useful link between the amateur glider pilot and the professional forecaster or research scientists. I would like to see more meteorologists fly. Education and research is all the better for being enjoyable, and if more meteorologists took to the air then out of their entertainment would come a better understanding of the air and its ways.



LEFT - 1865 Barometer.

CENTRE - Fortin Barometer 1895 which belonged to Sir Charles Todd. Used until 1963.

RIGHT - Kew Pattern Barometer 1910. Used by Sir Douglas Mawson on the Antarctic Expedition 1911-1914.

Instruments on display in the front foyer of the Bureau of Meteorology, Kent Town, S.A.

NATURAL DISASTERS - February 1977

by

Dr. R.L. Heathcote

What is a natural disaster?

We cannot define it in terms of physical measurements alone. Whatever happens must be associated with human activity. A flood, for example, is not always a disaster, but it will be if it happens in the middle of Brisbane. A drought is not called a disaster if it happens in the middle of the desert - it will be if many livestock are affected. We will therefore define a disaster to be an extreme geophysical event that adversely affects human activity, that greatly exceeds expectations in its severity, and that does these things on a scale that gives it a national significance.

Natural disasters tend to fall into two classes - 'intensive' and 'pervasive'. Intensive disasters happen in a limited period of time (minutes, hours) and in limited space (within a few kilometres, say). The chances of predicting them are poor. Earthquakes are of this kind. Pervasive disasters are cumulative, growing slowly over a long period of time, and are relatively predictable. They include drought. There are, of course, some in-between cases. The regional flooding that sometimes occurs in Queensland does not fit into either class.

Disasters cause significant hardships to a community, and the community responds by trying to adapt to them and to avoid them. Most of the research done on them has concentrated on what the public know about the risks of disasters in different places, and how they try to avoid them. More recent researchers have studied the response of a whole country, or even the whole world, to disaster.

A disaster can affect many things. It can change the landscape, if it is an earthquake or erosion. It can severely affect the population - the Bangla Desh cyclone of 1970 drowned a third of a million people and injured another quarter of a million. Indirectly it can lead to political unrest, and even to the overthrow of a government.

In the period 1947 to 1973, if we count only disasters that caused more than $100 million damage, killed more than 100 people and injured more than 100 others, there were about 833, natural or man-made, in the world (excluding Russia and China). These cost two to three thousand million dollars and killed some 828,000 people. For the whole world, that death rate is very low, however.

Researchers have studied the distribution of disasters around the world, and they have looked for changes in the pattern. The distribution is roughly:

Mountains	15%
Plains	15%
Coastal	41%
Ocean	29%

Note that the 'coastal areas' include more than half the world's population.

Cyclones occur in tropical areas around the world. Compared to such places as the Philippines, the Bay of Bengal and the West Indies, Australia sees very few of them.

Overall, disasters decreased in number between 1947 and 1973, but the number of large ones increased. Recorded deaths from disasters have increased since 1955, partly because communications have improved and have allowed us to hear of them more easily, and partly because the increase in population has forced people to use 'risky' areas more and more.

Prominent among Australia's disasters have been floods in the Hawkesbury River (early in our history) and droughts in South Australia. Where a disaster costs a state government more than 10% of its annual expenditure, it can apply for Commonwealth aid. Some $254 million was given in aid between 1947 and 1975, mostly after 1962. (This amount does not include the cost of the Darwin disaster because the Federal government itself spent the money.) The proportions of money spent were:

Drought	51%
Floods and storms	42%
Earthquakes	5%

The cost of insuring Australia's houses is about $60 million a year. The community also spends about $190 million a year in engineering work to prevent disasters. The estimated annual costs of different kinds of disaster (and for comparison, motor accidents) in Australia over the period 1945 to 1975 were:

	Millions of dollars	Deaths
Drought	100.5	0
Storm, cyclone	25.4	72
Flood	10.8	2.6
Bushfire	98.7	3.5
Earthquake	0.6	0
Motor accidents	200.0	3391

'Drought' is defined as a period in which rainfall is in the lowest 10% of values on record. The drought areas in Australia since 1910 have varied widely. Often they are in desert areas and are of little consequence. Of course in drought, as in other kinds if disaster, some people make a profit - by trucking starved cattle for example.

In Darwin, the damage from Cyclone Tracy was done in about 3½ hours. There were 65 dead and over 1000 injured. Insurance claims totalled about $200 million, of which about 45% came from the UK - perhaps this helps account for the recent troubles with sterling. The total cost was probably between $500 million and $1000 million. Of this, half was the loss of houses and their contents. Only 9% of the cost was in lost economic output, because most people were on holidays at the time.

The effect of a disaster, and the response to it, depend on the kind of society affected. In primitive societies, many lives are lost when the disaster strikes. The response is merely to replace destroyed crops, share food in the meantime, and so on. In technological societies, much effort is put into 'controlling Nature' and setting up warning systems. A disaster then takes few lives, but much material will be lost.

Thus, in Tanzania, the response to drought may be to vary the crops, ask the government to supply food, and pay the witchdoctor to prevent a re-occurrence (a doubtful investment). In Australia, the response would be to breed better crops, ask the government to supply money, and pay the CSIRO to seed clouds (also doubtful...).

The main organisation for handling disasters internationally has been the Red Cross (or Red Crescent in some countries), which helps to supply food and medicine. The United Nations has entered the field recently, but has helped mainly with co-ordination, more of an office job.

Within Australia, the National Disaster Organisation has been set up in Canberra recently to take over from the Civil Defence Organisation. It has headquarters in Canberra and a training centre at Mt. Macedon in Victoria. The states also have their own bodies, those of New South Wales and Queensland being the best organised.

What can be done about future disasters? Various bodies can help keep down their effects by identifying danger areas, predicting the approach of disasters, giving advice when one comes, and helping recovery afterwards.

Identifying flood hazards is easy - by studying a given area, geomorphologists can predict the probability of a flood exceeding any given size. Bushfire hazards can also be found - they vary considerably from place to place. Drought is harder - its range is always different and never covers the whole country at once.

The satellite photograph has helped greatly in predicting the approach of disasters. Many lives have been saved by it. Stream gauges give good warning of floods in the country, but for urban stormwater drains, whose flooding would affect a far greater part of the population, the coverage is very poor.

The National Disaster Organisation circulates pamphlets advising what to do when a cyclone strikes.

After the disaster, government help is needed. In Federal territory, there is no problem, but in states there can be disagreement over whether the state or Federal government is organising things. The experiences in Darwin have shown that evacuation may cause problems by splitting up families. Governments also take a dim view of people who build in areas of high risk, or who do not insure their property, but expect the government to pay. In future, there may be a system of 'drought bonds' that farmers will need to invest in to ensure aid in time of drought.

People often look forward to new ways to forecast disasters, but a reliable system will not necessarily help very much. The great San Francisco earthquake in 1906 left the city in a shambles. We know that some time there will be another earthquake that will destroy the city. We will probably be able to forecast the event, but will the forecast help? Given two years' warning of an earthquake near your home, what would you do?

Maps of impact areas would cause as much damage as an earthquake itself. Factories in those areas would stop; land could not be sold, so its value would still be lost. And what would happen after two years if the earthquake didn't come?

In some countries, all the effort that can be put into avoiding a disaster would not achieve very much. Would it be worth it to prepare for, say, a 1-in-100 chance?

At question time we learnt that the earthquake risk areas in Australia include areas east of Perth, in South Australia around the gulfs and Lake Torrens, Near Sydney, in Gippsland and in the Australian Alps.

Whatever fears the Bureau of Meteorology may have of being sued for predicting a disaster that does not come, it will have far more if it detects a risk and fails to report it...

At one time, tourist organisations threatened to sue the Bureau for issuing cyclone warning pamphlets. They went quiet only when a cyclone struck Hayman Island.

There have been suggestions that fluids be injected into the rocks near San Francisco to lubricate them and gradually reduce the earthquake energy stored there. Meanwhile, the recent 'big freeze' in the USA has proved to be as costly as the San Francisco earthquake, though without the great loss of lives.

More ships have been lost to weather than to wars.

Finally, we learnt of the problems caused by the tsunami warning service started in Hawaii. When a tsunami warning is issued, everyone rushes down to the beach to watch....

I DON'T KNOW 'WEATHER' TO TAKE IT OR NOT

THE 1976 DROUGHT OVER WESTERN EUROPE

by

G. Vecchio

The recent dry spell over much of Western Europe during the Spring-Summer of 1976 can be explained by the unusual anti-cyclonicity over the region. The most notably dry area was central southern England, where it has been calculated that on a statistical basis, such recurrence is less than once in 100 years (Ratcliffe, 1976).

This dryness can be related to the general circulation.

Figure 1, shows the mean monthly M.S.L. pressure for the months April to August 1977 and the average position of the Sub Tropical Pressure Ridge for January and July. From these maps it can be seen that during 1976 the high pressure systems were further north than normal. The surface pressure anomaly (mb) during October 1975 and April 1976 - Figure 2, shows that the Arctic has had much lower pressure than usual and most of the mid latitude belt has had higher pressure than normal with the British Isles near the positive anomaly centre. As a consequence of this, Atlantic depressions have, in general, been directed to somewhat more northern latitudes.

Associated with these circulation changes, sea surface temperatures have increased and accordingly the edge of the Arctic sea ice has moved further to the north from its extreme value of March 1969 (Figure 3).

A remarkable hot spell issued over southern England from June 23 to mid July 1977. During this period daily maxima of 30^{0}C were widespread and for 4 consecutive days starting from the 25th, 32^{0}C was recorded over much of London: the longest such sequence anywhere in the U.K. for at least 135 years (Weather Log, June 1976). As a consequence of the acute dry spell, it became very difficult for the authorities to cope with the increasing demand for water especially by industry and fire fighting services.

What are the reasons for such a hot spell? Apart from the obvious anticyclonicity over Western Europe one has to consider such facts as sea temperatures, the opacity of the earth's atmosphere and changes in global absorption of heat.

Namias (1964) attributed the prolonged drought affecting Scandinavia between 1958 - 1960 to a persistent anomalous sea-temperature pattern in the North Atlantic.

An increase in sea temperatures leads to a reduction in ice coverage which in turn leads to a reduction in the amount of reflected incoming solar energy and consequently to an increase in the absorptivity of heat.

An increase in solar absorption together with clear summer skies and light winds leads to early ripening of cereal crops and this too affects the reflectivity of the incoming radiation.

Finally the opacity of the atmosphere seems to be of late increasingly tampered with as a result of human activities. Because of the increased industrial output the amount of CO_2 and other photochemicals in the air is increasing; so too is the amount of dust largely due to the un-natural consequence of agricultural practices. Some of these activities if carried out on a very large scale, could upset the earth's radiation balance leading to changes in surface temperatures. Some of these changes will tend to increase the ambient temperature while others may tend to have the opposite effect.

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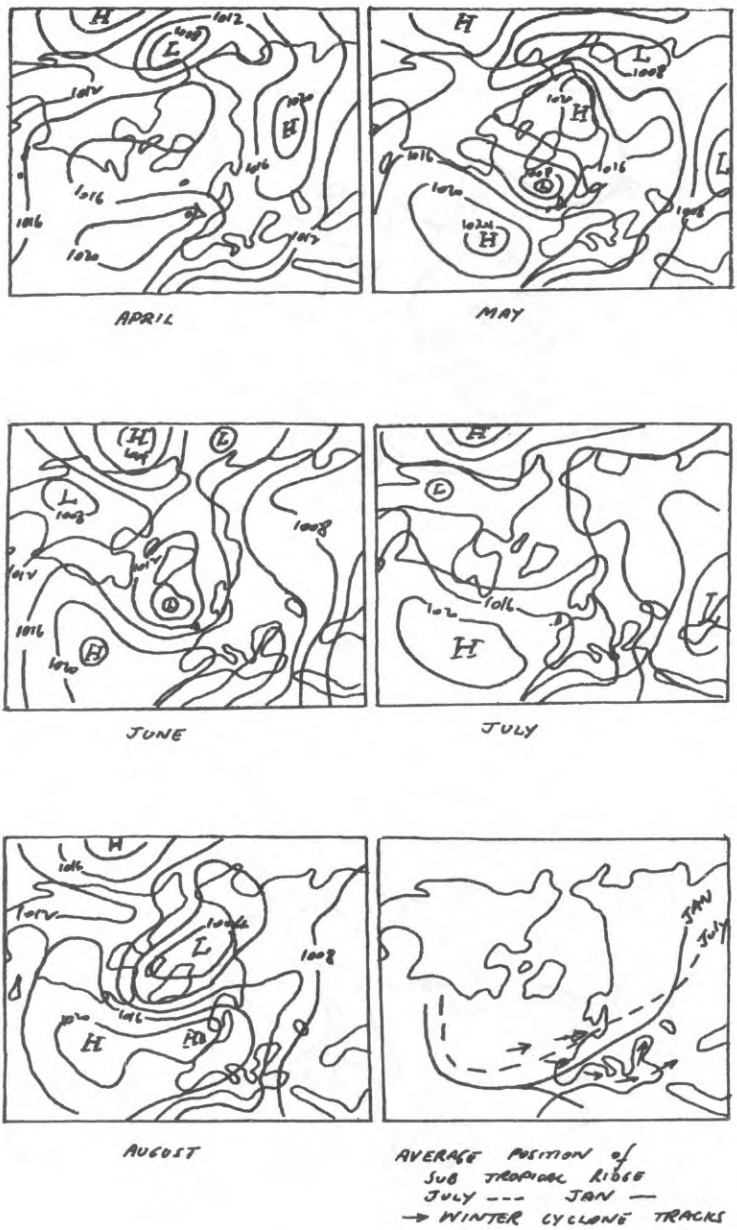


FIG.1. Mean MSL pressure patterns for April - August, 1976 and average position of Sub Tropical High Pressure Ridge (From Weather Logs, HMSO, London)

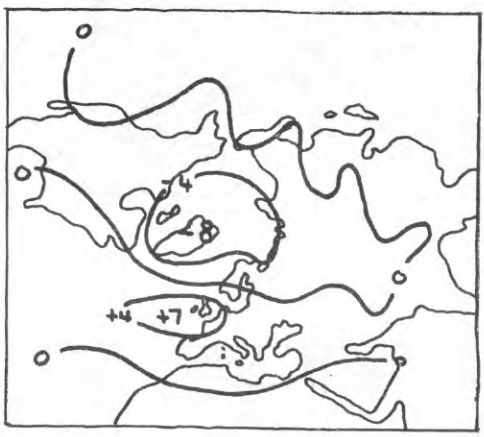


FIG 2 MSL pressure anomaly (mb) October 1975 - April 1976
(After Ratcliffe , 1976)

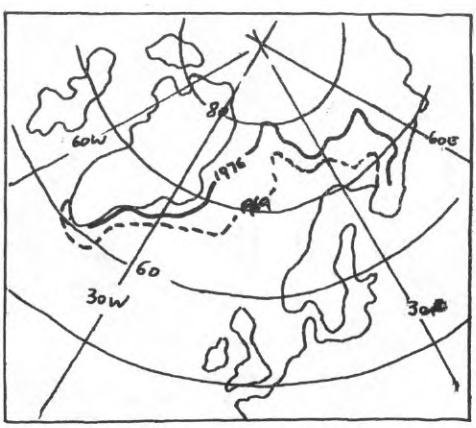


FIG 3 - Extend of ice coverage (After Ratcliffe, 1976)

HOT SPELLS IN ADELAIDE DURING THE 1975-76 AND 1976-77 SUMMERS

by

G. Vecchio, S.A. Regional Office,
Bureau of Meteorology

The summer months from November to March, for the summers 1975-76 and 1976-77 are considered. During this period there were 80 days when the air temperatures (as measured in the Stevenson's screen at West Terrace, Adelaide) reached 30^{0}C or over. Of these 6 equalled or exceeded 40^{0}C.

Table 1 compares these two summers with the long term summer average derived from all years 1857-1974 inclusive. The table indicates that the number of days for which the temperature was 30^{0}C or above was very close to the long term average. However, the number of occurrences when the temperature equalled or exceeded 40^{0}C was significantly above average for the summer 1975-76 and marginally higher during the summer 1976-77.

Table 1 Comparison of Summers 1975-77, 1976-77 with long term averages (all years 1857-1974 inclusive)

	Summer 1975-76 No. of Days		Summer 1976-77 No. of Days		Long Term Average No. of Days	
MONTH	$T \geq 40^{0}C$	$T \geq 30^{0}C$	$T \geq 40^{0}C$	$T \geq 30^{0}C$	$T \geq 40^{0}C$	$T \geq 30^{0}C$
Nov.	0	8	0	3	0	5.0
Dec.	1	11	1	8	0.3	8.3
Jan.	0	8	0	14	0.7	11.7
Feb.	3	14	1	11	0.2	9.2
March	0	0	0	3	0.1	6.3
TOTALS	4	41	2	39	1.3	40.5

Table 2 gives the long term summer (all years 1857-1974) average temperature maxima and minima and the hottest day on record for the months in question.

Table 2 Climatological statistics - Adelaide all years 1857 - 1974 inclusive.

MONTH	Av. Max. ^{o}C	Av. Min. ^{o}C	Hottest Day ^{o}C
Nov.	25.2	12.9	45.3 21/1865
Dec.	27.2	14.9	45.9 29/1931
Jan.	29.6	16.4	47.6 12/1939
Feb.	29.4	16.6	45.3 12/1899
Mar.	26.8	15.1	43.6 9/1934

Defining a hot spell as a period when for two or more consecutive days the air temperature was equal to or greater than $30^{o}C$, we find that over these two summers we have 22 occurrences in all (see Table 3).

Table 3 Number of consecutive days for which T $30^{o}C$ during Nov. - Mar. period for years 1975-1977

	Number of Consecutive Days						
	2	3	4	5	6	7	
Nov.	1	1	1				
Dec.	1	3					
Jan.	3	2				1	
Feb.	3	1	1	1	1		
Mar.		1					
TOTALS:	8	8	2	1	2	1	2

Table 4 lists the days during the summers 1975-1977 when the temperature reached or exceeded 37°C.

Table 4 Dates when Temperatures exceeded or equalled 37°C at Adelaide Nov. 1975 - Mar. 1977 inclusive

DATE			MAXIMA		MINIMA	
Year	Month	Day	°C	Time	°C	Time
1975	November	17	38.2	1600	21.0	0901
	December	1	37.2	1810	20.4	0510
		2	38.0	1545	24.7	0215
		10	39.2	1640	21.3	0545
		11	41.2	1620	28.0	0900
1976	January	3	39.3	1745	19.5	0540
	December	21	37.9	1830	25.3	0900
		30	40.5	1830	22.5	0900
1977	January	9	38.0	1230	24.2	0555
	February	10	37.0	1520	19.0	0720
		11	40.3	1545	23.3	0600
		16	37.7	1705	20.7	0430

(NOTE: No occurrences February, March, November 1976, and March 1977)

The most memorable hot spell on record in Adelaide was that of the heat wave of January 1939 when for 14 days out of 15 the temperature exceeded 32°C (90°F) and of these 9 exceeded 38°C (100°F). During this period, on January 12, the record Adelaide maximum temperature of 47.6°C (117.7°F) was experienced.

Figure 1 shows a typical heat wave sequence which was experienced during the second week of December 1975. During this period a maximum temperature of 41.2°C was recorded at 4.20 p.m. on December 11. At 7 p.m. on this same day, the temperature was 40°C and by 8 p.m., following the passage of the front, the temperature dropped to 32.5°C and continued to fall thereafter to a low of 23.3°C at 6 a.m. on the next day (December 12). A continuous picture of the temperature for these days is shown by graph 1(a); humidity changes are shown in graph 1(b).

Graph 1(b) is a plot of the dew point temperature with respect to time.

The dew point temperature of the air is that temperature to which the air at a given pressure must be cooled in order for it to be saturated. The dew point temperature is thus a representation of the moisture content of the air and is therefore related to the relative humidity. As can be seen from graph 1(b), the dew point temperature remained almost constant prior to the change. After the cool change the humidity of the air increased as evidenced by the increase in the dew point temperature, which reached a maximum of just over 19°C. It thereafter began to fall as moist southwesterly winds turned more southerly and eventually shifted to drier southeasterly.

During the summer months the relative humidity in Adelaide is comparatively low (approximately 40% on average) and this explains why summers, even during heat wave conditions, are not unduly severe for personal comfort. Any degree of discomfort is generally associated with the sultry conditions which can prevail just prior to and a little after the advent of a cool change.

On February 3, 1977 the Adelaide Regional Office moved from West Terrace to its new premises at College Road, Kent Town. While observations are still being made at West Terrace for comparison purposes, official temperatures for Adelaide are now read at the Kent Town site. The temperatures used above are those obtained from the West Terrace site. A comparison between maximum and minimum temperatures for these two sites for days since February 1977 when temperatures exceeding 37°C occurred at any of the two sites is shown in Table 5. However, the sample in Table 5 is too small for objective analysis and any worthwhile comparisons cannot be made until an adequate amount of data has been collected over at least a few years. It is noted in passing that no temperatures above 37°C occurred in Adelaide during March 1977.

Table 5 Comparison of Maximum, Minimum Temperatures for Adelaide (West Terrace) and Kent Town during February 1977 when T $\geq$ 37°C

DATE			WEST TERRACE				KENT TOWN			
			MAXIMA		MINIMA		MAXIMA		MINIMA	
Yr.	Month	Day	°C	Time	°C	Time	°C	Time	°C	Time
77	Feb.	10	37.0	1520	19.0	0720	38.3	1530	17.0	0655
		11	40.3	1545	23.3	0600	39.7	1155	21.3	0910
		16	37.7	1705	20.7	0430	38.9	1710	18.8	0710
		17	35.4	1155	25.0	1620	37.5	1230	25.0	0900

(NOTE: On February 11 when West Terrace recorded a maximum of 40.3°C at 3.45 p.m. the maximum at Kent Town was 39.7°C recorded at 11.55 a.m. However, at 3.45 p.m. the temperature at Kent Town was 39.6°C, just a fraction below the day's maximum).

ACKNOWLEDGEMENTS

I am indebted to the S.A. Regional Office of the Australian Bureau of Meteorology for the provision of the data used in this work.

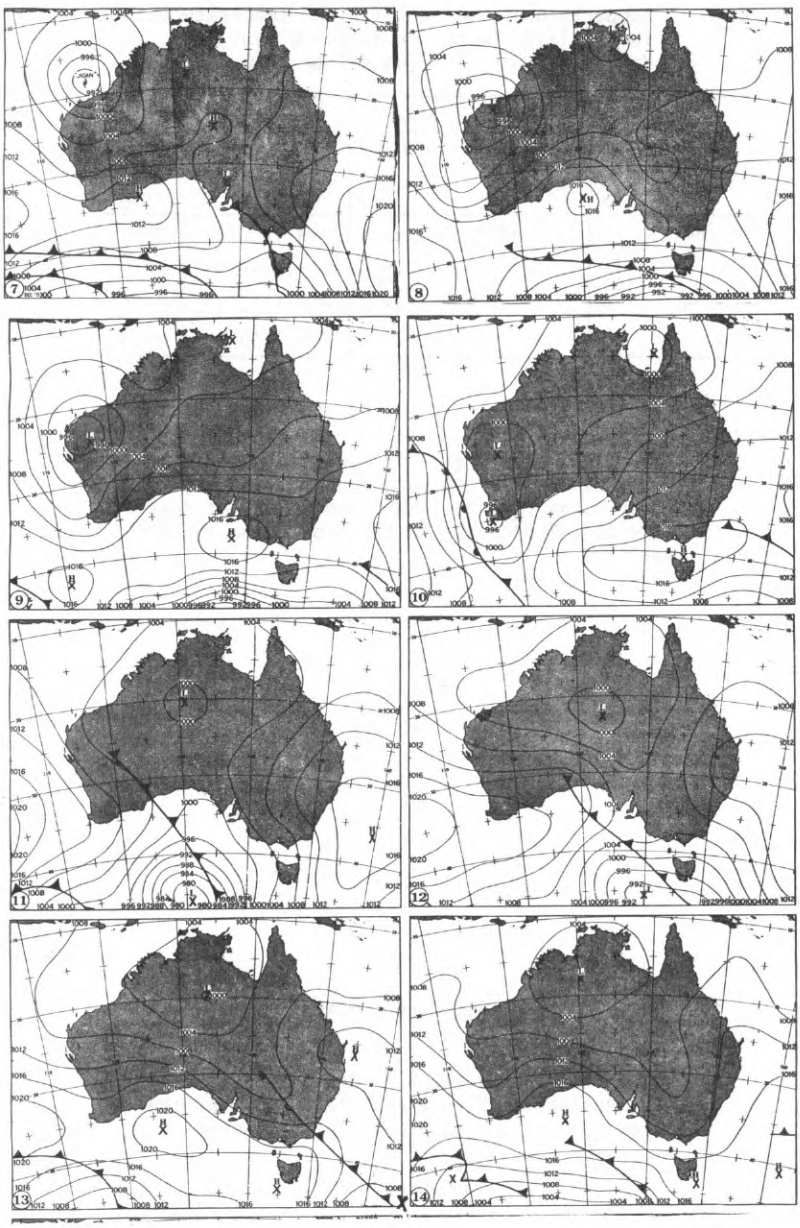
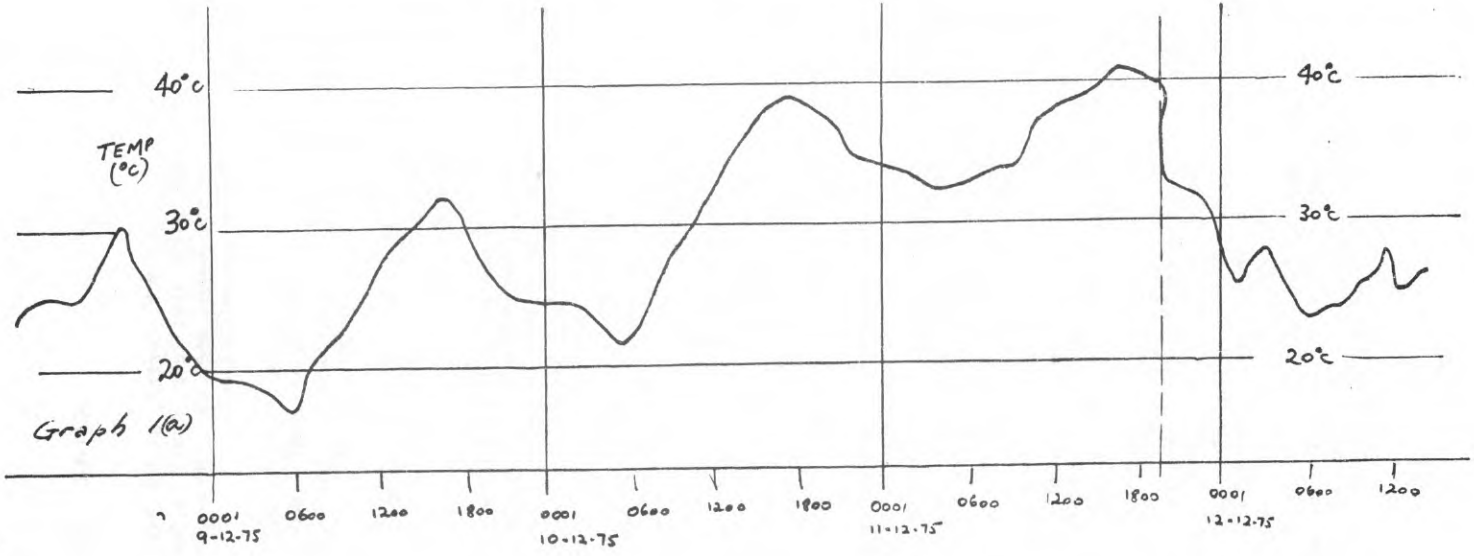
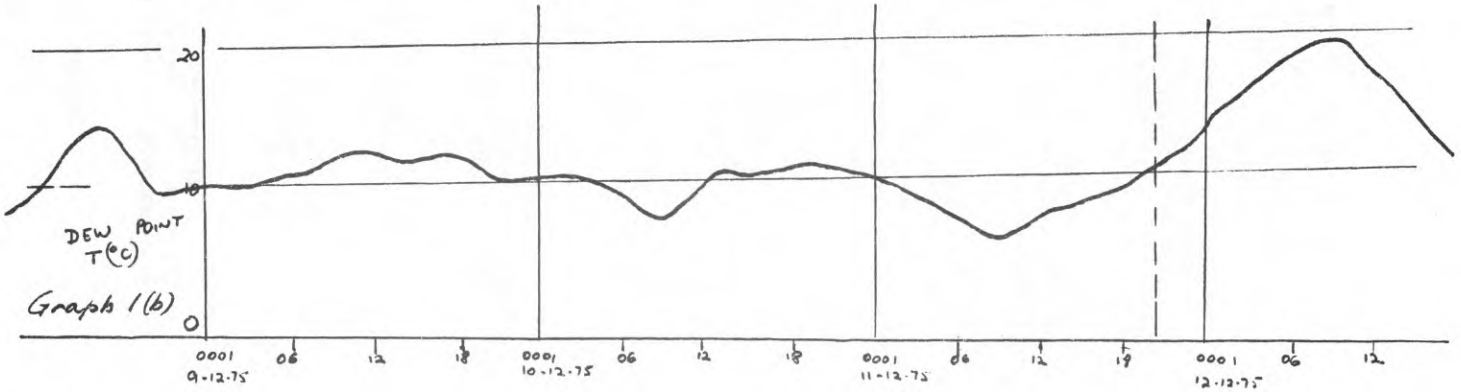


Fig. 1. 9 a.m. Synoptic charts for heat wave situation experienced at Adelaide December 7 - 14, 1975.





Graph 1(a) Plot of Temperature (°C), versus time, Dec. 9-12, 1975.

Graph 1(b) Plot of Dew Point Temperature (°C) versus time, Dec 9-12, 1975.

SCATTERED FUNGUS-SHOWERS

Dr. M.V. Carter, of the Plant Pathology Department of the Waite Institute, spoke on "Weather and Plant Diseases" at the August meeting. He began his talk with the following definition:

> 'Disease is not a condition: it is a series of harmful processes caused by continuous irritation of the plant by a primary agent.'

We usually detect a plant disease by symptoms, and these symptoms are usually specific to the agent that causes the disease.

Since the beginning of written history, theories about the causes of plant diseases have greatly changed. At first they were blamed on supernatural causes. Later it was considered that bad weather and bad soil were the problem. In the last hundred years or so we have learned that there are two kinds of disease, 'parasitic' and 'non-parasitic'. Only in the last fifty years have we discovered that weather also has an effect, even where it is not the main cause of a disease.

Non-parasitic diseases are caused by the deficiency of an element necessary for growth, the presence of harmful substances, or unsuitable weather. For example, Hydrangeas near new brick walls may go motley because the lime from the mortar absorbs iron, a soil element that these plants particularly need.

If tomatoes go unwatered for a time the fruit sometimes develops hard patches on the side opposite the stalk. These are caused partly by water shortage, but partly by an imbalance of calcium. The 'whip-tail' disease, which affects cauliflowers but not cabbages, is caused by a molybdenum deficiency but is not affected by the weather.

Weather conditions that harm plants most are low temperatures in spring when they are budding, and high temperatures in summer which scorch the leaves and may even cause the plants to drop their leaves as a final defence.

Atmospheric pollutants readily damage plants. The sulphur dioxide found near brick kilns turns the leaf tissues yellow between the veins and can kill the plants if strong enough. There are soil pollutants, too. Incorrectly used insecticides are an obvious case, but plant deaths from leaking town gas occur, too. The number of these seems to have increased since natural gas came into use. One theory is that natural gas does not have to be washed to remove impurities, as coal gas does, so it is much drier. It dries out and shrinks jointing material and causes leaks to appear.

Parasitic (or infectious) diseases have micro-organisms as their agents. They can be caused by fungi, bacteria, viruses or nematode (or eel) worms. Fungi are the biggest problem - of the hundred thousand odd plant diseases, only a few hundred are caused by other agents.

The best known fungus disease, rust or 'blight', is referred to in the Bible (see I Kings 8), where it is called 'blasting'. The ancient Hebrews considered it and other plant diseases to be a divine punishment which can be avoided by appropriate behaviour. The ancient Romans could not decide whether this disease was brought on by the gods, the weather or the soil. They noticed that the rust was heaviest in low-lying parts of fields, and that it affected some plant varieties more than others. They considered frost or dew with sun as a possible cause.

Micro-organisms were not detected until well after the invention of the microscope. As late as 1850, people still believed that fungi grow on plants only when they are already diseased and decaying. We now know that the fungus itself can cause a disease.

Fungi have no chlorophyll and cannot make their own food like plants. They require sugar, nitrogen compounds and moisture to survive. In adapting to absorb these things from their surroundings, they risk losing their moisture in dry conditions, so shelter is essential. The host provides both food and shelter for them.

For a fungus to infect a plant, four conditions must be satisfied:

1. The plant must be susceptible. Most plants can resist most fungi, so for a given fungus, some plants are suitable hosts, but most aren't. For example, the 'Dutch Elm Disease' in the news recently affects only English and American elms and nothing else.

2. The plant must be in a vulnerable state. Generally young leaves are more readily attacked, so plants are more susceptible in spring. Injury to a plant may make it more vulnerable. For example, gummosis ('dieback' in apricots) only occurs after the trees have been pruned.

3. The parasite must be in an infective state. Most kinds have two forms, a 'survival' form and a 'dispersal' form or 'spore', and spends some time in each form.

4. Environmental conditions must favour dispersion and survival until the parasite can germinate and enter the plant. For a fungus, the environment is sometimes the air, sometimes the soil, and sometimes the plant. Fungi that remain in the roots and soil are, of course, less subject than others to the weather. Weather factors that most affect fungi are sunlight (in which ultra-violet radiation is lethal to micro-organisms), temperature, moisture in the forms of vapour, dew and rain, and also wind.

The 'silverleaf' disease of apricot and apple trees is an example of a fungus disease. The fungus lives in the wood of the trunk and produces its fruit near the ground, but makes a toxin which turns the leaves a silvery colour.

Another fungus disease, powdery mildew, infects several species. It grows partly on the leaf cells and partly on the leaf surface, where it appears as white patches. After rain, chains of spores are produced and the leaf patches have a more furry appearance. After wind, the furriness is gone - the spores have dispersed.

Rust is not really a single disease but a number of similar diseases that infect different plants. The fungi involved grow wholly inside the plant. The spores grow just under the skin, bursting through as they ripen, and can be blown or washed away.

Fungi have many tricks for dispersing their spores. Their ripening and dispersal are strongly affected by weather conditions. The best-known fungus, the mushroom, drops from its gills spores so light that even a gentle breeze will spread them. Some spores are dispersed by rain. They do not wet easily and float away on a thin film of water. As a raindrop strikes the film, there is a splash and small drops carry the spores away.

The 'black spot' disease of apples grows on the leaves and fruit. It remains there, falling with the leaves in autumn, remaining on the ground through winter and ripening in spring. Spores are then released when rain falls - as little as 1mm is enough.

Gummosis affects the wood around a wound, usually causing a whole branch to die. If the branch is removed and left on the ground, the fungus will ripen and appear as a black surface layer about 2 years later. A millimetre or so of rain triggers the release of spores, which are carried by wind to a wounded tree. Usually the wound that causes the trouble is a pruning cut.

Simple experiments with healthy plants that have been sprinkled with spores show that the plants must be continuously wet for a certain period of time to become

infected. The time required is greatly reduced by increased temperature. The explanation for these facts is known - when a fungus spore comes into contact with plant cells and moisture, it begins its growth above the surface. When it has grown sufficiently it breaks through the outer skin and begins to use the plant's moisture. The initial growth is faster when the temperature is higher.

We can use our knowledge of the effects of weather to help avoid plant diseases. As a simple illustration, some diseases of peas only infect plants grown in winter. Those grown in late spring and summer are quite safe. The conclusions are obvious.

The downy mildew that infects grape vines appears every year. In wet summers it requires regular spraying. In Adelaide there is normally no need to spray, but the odd wet summer can bring on an unexpected big infection.

It is known that if a wet summer follows a year when rust is common, rust can occur out of its normal season. An epidemic may follow, and warnings to this effect can be issued by the Bureau.

Where a disease can be brought on by short-term weather conditions, a grower can be helped if these conditions can be detected, and if he can be advised either that a spray is required soon, or that it is not required. This is a matter of measurement rather than forecasting. It is assumed that a spray is available that can cure the disease for at least a short time after infection - this is possible, for example, for black spot in apple orchards in the Adelaide Hills, also for tobacco blue mould disease in the Ovens Valley.

The warnings are based on measurements of temperature and duration of wetness. Instruments include a spore trap, a recording rain gauge, and a leaf wetness recorder which consists of a block of polystyrene foam, counterbalanced by a pen in contact with a moving chart. Such instruments are simple enough that local people (such as the manager of a packing shed) can issue their own warnings.

There are warning systems for some other diseases in other states, but not many.

Virus diseases are transmitted by insects. Weather can affect these diseases by affecting the flight of the insects. Unfortunately this knowledge has little application yet, because no sprays are available to fight the diseases.

(as taken down by R.J. Whatmough)

WEATHER AND WINE

by

T.C. Somers

The Australian Wine Research Institute, Adelaide.

Your request that I talk to you on this subject has obliged me to look into climatic factors which are fundamentally responsible for much of the variability in wine composition and quality, the nature of which we seek to elucidate in oenological research.

However, we should begin by consideration of the vine and its perennial function of producing the wine grapes from which a good wine might be made.

The Vineyard

The vine, like any other organism, has to adapt, if it can, to the environment in which it is situated. It has an inbuilt set of genetic instructions which basically determine how it may grow. However, the vine also responds to its habitat by reacting to a wide range of environmental stimuli. Each of these has an optimum which is flanked by values ranging from less than optimal through stressful to intolerable.

Thus the environmental variables, which refer principally to climate and soil factors, determine the vine's ecological niche, with climate much the more important influence on vine physiology and growth. It is not surprising, then, that there is such wide variation in wine composition and wine quality from different regions.

In this account, I shall be referring exclusively to the vines and wines of *Vitis vinifera*, the European wine grape species, the many varieties of which have been propagated on all continents of the world.

Berry Ripening and Harvest Requirements

The leaf is the laboratory of the plant, Photosynthesis from atmospheric carbon dioxide and soil moisture produces sugars, organic acids, amino acids and other necessary organics which migrate into the ripening berry. Minerals are taken up from the soil via the root system which, in the vine, can be very extensive. Pigments and related phenolic compounds are synthesised in the berry.

The wine grapes are ready for harvest when they have reached full colour and aroma at the desired balance of sugar and acidity. The quantity of sugar produced depends on the heat and light input during the period of maturation. Thus a warm climate is essential for successful viticulture.

Under good growing conditions, the wine grapes will attain 20 - 25% sugar at a sufficient level of acidity for the making of sound wines having 10 - 12% ethanol content.

Constraints by Low Temperatures

The effect of winter severity on vine growth is described in terms of minimum temperatures during the wine's dormancy. Generally speaking, the vine is limited to areas where the average temperature of the coldest month is not less than -1°C. Frost can be fatal to vines, and it appears that there must be at least 180 frost-free days during the growing season.

Low summer temperatures will also set limits to successful viticulture, the requirement being usually given as a minimum of 19°C for the average monthly temperature of the hottest month.

However, low temperatures do have one important function in relation to vine growth, for chilling is necessary to break physiological dormancy. Bud burst will not occur in Vitis vinifera until the vines have been exposed to a period of cold weather. For most varieties, this is about 10 - 15 days in which temperatures fall below about 7°C.

Influences of Higher Temperatures

Excessive heat can block photosynthesis and inhibit the normal maturation processes in the berry. High temperatures are usually accompanied by high light intensities; the increased photosynthetic rate and higher respiratory rate result in an imbalance in the critical sugar/acid ratio, the grapes becoming high in sugar and low in acidity.

In the hotter viticultural areas of Australia and elsewhere, the growing season is much shorter than in premium wine districts, the more rapid ripening having the effect of diminishing varietal flavour and lowering grape acidity.

Minimal Heat Summations

The concept of 'degree days' has long been used by vine climatologists to describe minimum heat requirements for successful viticulture. This is a form of temperature summation with a base of 10°C (the minimum effective growing temperature of the vine) from the period between bud burst and grape maturity. On this basis, for example, the wine districts of California have been classified into five regions.

Grape varieties vary widely in their requirements of solar radiation during ripening, in that early maturing varieties need less total heat than do late varieties to

reach maturity; the range in degree days being nearly two fold between early ripeners like Riesling and Pinot Noir and late ripeners like Muscat Gordo and Doradillo. Thus restrictions on wine grape variety are imposed at the cooler limits of the vine, as in Northern Europe and parts of the U.S.A., but hardly at all in Australia where heat summations are generally ample for all varieties. This does however mean that much of our harvest, particularly that from early ripening varieties, reaches maturity during a period of fairly high temperatures with rather adverse influence upon sugar/acid ratios and varietal flavour. High temperatures also inhibit pigment development in the berry, deeper wine colour being a characteristic of wines from cooler districts.

In general terms, optimal growing conditions could be described as featuring a high level of solar radiation at reasonable day temperatures (24^{o} - 28^{o}C), giving efficient photosynthesis and a low rate of respiration.

Rainfall and Irrigation

Unless the water regime is adequate, normal vine growth cannot occur. Lack of water reduces leaf area and so will affect berry growth and sugar production.

The amount and frequency of rainfall required depends upon the soil type and depth. Provided that the soil is able to retain water in the root-zone of the vine, 20 inches p.a. is about the minimum needed for economic production.

Because of inadequate rainfall, much of the wine production in Australia is dependent upon irrigation. As in other countries, this has enabled vast areas to be put under vines in spite of adverse natural climatic conditions.

The Micro-climate

Near the cool limits of the vine, the advantages of establishing vineyards on favoured slopes with a southerly aspect have long been recognised. Similar considerations apply in some Australian wine districts where the aim should be to minimise heat summations for early maturing varieties by planting on a southerly aspect. New plantings in southern parts of Victoria and in Tasmania can, in contrast, benefit from location on favoured northerly aspects of maximise heat and solar radiation, as intended in the Northern Hemisphere.

What really counts, therefore, is not so much the overall weather pattern for a region, but the immediate environment close to the vine - the term 'micro-climate' is used in reference to the total integrated influence of all environmental factors upon the growth habit and product of the vine. Such local features as soil moisture, soil temperature, humidity, exposure of the berries to solar radiation all have influence upon grape composition and therefore upon wine quality.

It is probably only by reference to such micro-climatic factors that we can possibly hope to elucidate the fine distinctions in balance and flavour which separate the best premium wines from those of lesser quality in adjacent vineyards.

Seasonal Variation and Hazards

It remains only to mention that the wines of all regions, particularly those near the limits of vine cultivation, are prone to seasonal variation. Optimal growing conditions for the making of 'great wines' might occur about every other year in Bordeaux and Burgundy, whereas insufficient solar radiation for adequate maturation of the wine grapes is more commonly a problem in the cooler wine districts of Alsace and Germany.

As mentioned, heat summations are more than adequate in most Australian viticultural areas, where cooler seasons, particularly in the later stages of ripening, generally result in a better vintage. Contrary to some public opinion, there is considerable variation in composition and quality of the Australian vintage, as in other wine districts of the world.

Adverse weather conditions, particularly at certain stages during the growing season can have serious effects upon harvest yield and condition, e.g. frost at bud-burst in early spring, an unusually dry spell at the time of flowering and rains at harvest time, which can cause the berries to split, leading to mould or fungal infection of the crop.

Even after the harvest, the weather is a factor in wine-making, particularly in Australia, where continuing hot weather can make it difficult for the winemaker to conduct the vinification with appropriate temperature controls.

To summarise a popular verse, a good wine is a product of many influences, most of which, given a competent wine-maker, are conferred or inflicted upon the vine by prevailing weather conditions.

TRIALS AND TRIBULATIONS OF PRESENTING THE WEATHER TO AND THROUGH THE MEDIA

Those who attended the June meeting in deepest Glenside were amply rewarded by the talk on weather in the media given jointly by Mr. Jack Noone of the ABC, and Mr. A. Broadbridge and Mr. Hogan of the ABM. The fact that a representative of a commercial TV station was present in the audience added some extra spice to the occasion.

The Bureau doesn't issue much routine information to the public directly - it relies on radio, TV, and the newspapers to do the job. Generally they are happy to do it because they know that the public are interested, but there are moments...

Sometimes a newspaper reporter calls for a 'weather story'. This usually means that something unusual has happened or that the paper is running short of news. If there has been an unusual event, the Bureau can be taken by surprise - this may be the first news of it. If the reporter is the young, inexperienced kind the main worry is whether he will get the statements correct and into context. In this case he may be asked to ring back with his story so that it can be checked. If nothing more is heard, the Bureau will ring him.

Even when the reporter has written accurately, his story is subject to the whims of the man who lays out the headlines. Once, in football season, an Adelaide paper asked for a Saturday forecast. The Bureau noted that the barometer was rising and that subsidence was in force, so that there was little chance of rain during the afternoon. Their forecast said 'overnight showers'. The headlines read 'RAIN TIPPED FOR FOOTBALL' and there were photographs of queues of people holding umbrellas!

In giving the forecast itself, reporters from all the media like to bear good news, especially for a long weekend. They will try to put 'fine' into it somewhere to suit the public. Even sporting announcers like to say 'it's a lovely day here at so-and-so' and avoid to mention any heat or rain. For these reasons, the Bureau insists that the media pass on all forecasts verbatim. In return there is much abuse from the media. If the Bureau complains to an offending radio station and misquotes the forecast that was broadcast, the station will gleefully produce tapes that prove that the Bureau was mistaken.

Then there was the one about the radio station that got every forecast twice - once directly and once through an interstate news agency by contract. When the Bureau tried to cut the waste by stopping the direct service, the more-travelled version was found to be too abbreviated and too late to use. So arrangements were made to use direct forecasts only. Still the

forecasts were late - the telex and newsroom were at opposite ends of the building, and the staff were in no hurry to collect the new forecasts. Further complaints were made and the problem is no longer.

Generally the Bureau has to be very careful with the media. They tend to have the last say in any argument. But they know that the public want the forecasts, and if the Bureau threatens not to supply them (which has happened at times) they respond rapidly....

At the ABC, the Bureau staff are regarded as associates. There is a written agreement which gives the Bureau the last say on the content of the forecast, and the ABC the last say on its presentation. The two organisations welcome each other's comments.

Independent ratings are a very hush-hush affair, but the ABC's own private ratings show clearly that the weather forecast is an 'audience puller'. Many more watch it than would find it of value. (It is apparently well known that a certain blonde weather girl on commercial TV attracted many viewers who could not remember the forecast immediately after!) Because the ABC's Rural Department has a particular interest in the subject it has been given the job of passing on all weather information.

ABC radio's number one tribulation is that it has to give forecasts for the whole state, and fit them into a complicated schedule for several networks. The schedule is drawn up three weeks ahead and there are amendments to keep track of, too. There just isn't time to give all the information people might want at times convenient to all. That is why the coastal reports so favoured by yachters can only be put on at 6 a.m.

TV's problems are worse. If the evening news runs a little long, a slight delay to later programs can be tolerated. But if a special national program - say an announcement by the Prime Minister - is sechduled next at short notice, it will be the weather that is cut short. On one such occasion the announcer was given thirty seconds - he carried gamely on with his attempt as the map came down around his ears!

The ABC is also limited by the number of staff available to prepare charts and other displays for the TV forecast. For this reason it is not yet able to include 'neph' analyses (nephelometric or cloud analyses of satellite photos) in their forecast as are given in other places.

In short, if the ABC had 25 hours a day to work in, and money to hire lots more staff, there would be no trial or tribulation at all.

The following gems show what problems the Bureau has with commercial radio (and vice versa?):

- Breakfast announcer to mate who has disagreed with the forecast:

  'A few years ago if you said that the chap up there would have you down on your knees apologising!'

- Another announcer, after the Bureau had complained about the forecast broadcast incorrectly:

  'The Bureau has amended the forecast....'

- Same announcer to Bureau over the phone after a further complaint:

  'We couldn't find the first forecast so we used yesterday's....'

People have asked for upper air charts to be shown on TV. The Bureau has resisted this idea, because such charts are hard to explain to the public. If the public doesn't understand them, what is the point of giving them?

People are also very fond of the overseas capital temperatures in the newspapers. Such temperatures may be maxima two days old, but nobody cares.

The amount of training a TV weather announcer has in his subject varies widely. ABC announcers come to the Bureau for a briefing before their appearance. Some stations interstate and overseas employ professional meteorologists.

Many questions were asked of the three speakers and some questions for improvement in weather reports in the media were made. We learned:

- That the coastal weather stations were once the entire network for South Australia, but the forecasts were good even then.

- That Kangaroo Island still lacks advance warning of weather changes, though satellite photos have made forecasting a little easier in this area.

- That the ABC do not have the staff to run the studios to give additional early-morning forecasts on radio.

- That as long as the ABC has to cram its TV forecast into 3½ minutes, we will have to be content to see tomorrow's temperature on today's chart and go without any explanation of past weather.

- That despite their smiles, the ABC's TV weather announcers regard the weather as deadly serious, and rehearse constantly for half an hour before delivery - made without idiot sheets!

- That satellite pictures require special knowledge to interpret and they are not likely to be shown on TV for this reason.

- That announcers are too repetitive but reluctant to change their style.

At the end of the evening, though we did not all agree on the kind of weather service we wanted through the media, we did have a clearer picture of what it takes to provide that service.

(as taken down by R. Whatmough)

OWING TO A DEPRESSED AREA IN THE PYRENEES REGION, THE RAIN IN SPAIN WILL PRECIPITATE MAINLY IN THE PLAIN AREAS
by order
– G.R.S.
METEOROLOGY
ADELAIDE DIVISIONAL OFFICE
NEVER USE TWELVE SMALL WORDS WHERE THIRTEEN LARGE ONES WILL SUFFICE
THE TEMPERATURE IN THE SUN IS EXTREMELY HOT, MATE – EXTREMELY HOT, RISING AT TIMES TO 140°F – WHAT IS IT LIKE UNDER THE PORTICO?
"IT IS 115°F AND THE REFRIGERATOR IS SHOT!"
"... A CRUCIAL FEATURE OF THE SYNOPTIC SITUATION!"

AN ADVISORY SERVICE FOR IRRIGATION FARMERS ON THE NORTH ADELAIDE PLAINS

by

C.M. Purton

During the 1950s and 1960s the population of Adelaide increased rapidly. Much of the city's traditional market gardening areas, such as the Western suburbs and the Torrens Valley, were subdivided for residential purposes. To replace these market gardens, and to expand vegetable production to meet the demands of an increased population, many vegetable gardens were established in the North Adelaide Plains area. This is the district around Virginia, Two Wells and Angle Vale where the Gawler River makes its way across the plain to the sea.

As the natural rainfall of the area is not sufficient to grow vegetables, irrigation is necessary. Most of the water used for irrigation is pumped from ground water reserves under the plain by means of bores. By the mid 1960's it became apparent that more water was being pumped from the ground water basin than was flowing in from recharge areas. Measurements showed that the water table was dropping each year. Fears were held that if the water table dropped too far, seawater would infiltrate into the ground water basin and raise salinity levels.

In 1970 meters were installed on all bores in the North Adelaide Plains, with water quotas being allocated to all users in 1971. If a grower uses more water than his quota, he is liable to be fined.

In this context it is to the advantage of the vegetable grower (and indirectly to his customers) to use his water quota as efficiently as possible. That is, to use a fixed amount of water in such a manner as to obtain the maximum yield.

Where does the Water go in Vegetable Growing?

A plant absorbs water through its root system. This water passes through the plant and is released to the atmosphere through the leaves.

This process is called transpiration. The amount of water passing through the plant increases with increasing solar radiation and air temperature, and to a lesser extent with increasing wind speed and decreasing humidity. Therefore plants need more water in summer than in winter.

In addition to water transpired by a plant, the soil surrounding the plant (and moist plant leaves if spray irrigation is used) loses water to the air by evaporation. The rate of evaporation is influenced by the same factors as transpiration. The combination of transpiration from the plant and evaporation from the soil it grows in is termed evapotranspiration.

It is necessary to apply more water to an irrigated crop than the amount used in evapotranspiration. This is to prevent a build up of salinity near the crop root zone. This additional water tends to seep down to the water table, carrying the dissolved salts away from the crop root zone.

The natural rainfall of the North Adelaide Plains area is between 400mm and 450mm per year on average. Two thirds of this rain falls in the 6 months from May to October. The summer rainfall is not sufficient to maintain growth, and supplementary irrigation is necessary.

The amount of water needed for supplementary irrigation increases as the natural rainfall decreases, and increases as air temperature and solar radiation increase.

How to make Efficient Use of Irrigation Water

A common way to determine the amount of irrigation water to be applied to a crop is water budgeting. Like financial budgeting this means keeping a tally of losses or gains, and keeping them in balance. The grower estimates the loss of water from the crop due to evapotranspiration, and estimates the amount of water which should seep away. The total of these two should be balanced by natural rainfall and irrigation water.

Evapotranspiration depends on crop type and stage of growth. Evapotranspiration also depends on the soil moisture deficit, i.e. the evapotranspiration from a well watered crop is greater than the evapotranspiration from a crop under moisture stress. Assuming that the crop is sufficiently well watered, evapotranspiration can be estimated by multiplying the evaporation from a free water surface by an appropriate crop factor. For the North Adelaide plains the Department of Agriculture has suggested crop factors which incorporate leaching factors (i.e allow for extra water to seep down into the water table). These crop factors range from 0.4 for crops which expose areas of bare soil around the plant, to 0.7 for crops where leaves of adjoining crops touch thus covering the soil.

An Experimental Service Publishing Values of Evaporation

During the summer of 1975-76 the Bureau of Meteorology instituted an experimental service publishing daily values of evaporation for the North Adelaide Plains.

Daily evaporation was measured at Edinburgh aerodrome, Parafield aerodrome and Bolivar Sewerage Treatment works using U.S. Class A pan evaporimeters. These three readings were averaged to give an estimate of evaporation for the plains area. This estimate was broadcast on the ABC country hour, with a 72 hour total by 9 a.m. being given on Monday, and 24 hour totals on Tuesday to Friday.

To use this information a vegetable grower first has to total the evaporation since he last irrigated his crop. By multiplying this figure by an appropriate crop factor the water loss by the crop can be calculated, and hence the amount of water to apply by irrigation can be calculated. The frequency of irrigating is left to the discretion of the grower.